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Butterflies as an indicator of the natural environment—an attempt at monitoring at a private house garden in Oita, Japan

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Abstract Butterfly watching was carried out at a small house garden of Fujimigaoka New Town, Oita City, for three years from 1998 to 2000. In contrast to the "route census method", we did not have a fixed time for butterfly observation because of working during the daytime in another place, and also not always being at home during holidays. Hence, observation was carried out only at certain times. However, we fixed an observation place in the garden of Miyata's house and several meters around it to be able to watch and to identify butterflies. Even under such limiting conditions, a total of fifty species of butterfly was observed in the garden during the period. In the present paper, yearly and monthly appearances of each species and also frequency of its numbers were evaluated by total number of appearance days in each year and for three years, and the number of individuals in each half month classified into three grades as shown in Table 1. The number of butterfly species observed during the holiday was always more than that on weekdays. During the summer season, most of the butterflies, about 70 to 100% of butterflies seen in a day, appeared before noon, especially from eight to ten o'clock in the morning. We believe that if during every holiday the observer could stay in his house until ten o'clock in the morning, he could observe almost all species that would appear in his garden in a year. Therefore, our method may be recommended as a useful method of monitoring butterflies instead of the "route census method".

Key words Butterfly watching, monitoring of natural environment, new observation method, route census method.

The Committee of the Nature Conservation of the Lepidopterological Society of Japan appealed to members of the Society in 1998 to begin the activity of monitoring butterflies in each house garden. The first author accepted the proposal and continued butterfly watching at a small house garden of Fujimigaoka, Oita City, for three years. He began watching casually without much thought, but soon he became enthusiastic because even in his small garden he found very interesting behaviors for each butterfly species (Miyata, 1999, 2000*a*, 2000*b*, and 2001). However, after three years of observation at Fujimigaoka, he wanted to have a small private institute in Kokonoe Highland, Oita Prefecture, for the observation of insect behavior, especially Lepidoptera. The institute opened at the end of 2000 as the Kokonoe Institute of Natural History. Then, he began to observe insect behavior every weekend and during holidays in the Highland, and he could not continue to observe butterflies at Fujimigaoka except in the morning and the evening during weekdays. Therefore, he wanted to discontinue butterfly watching at Fujimigaoka in November 2000.

Recently, we collaborated to reexamine his data in detail and through our discussion compiled the data into the present paper.

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Method of observation

1. The observation place is a small private garden of Miyata's house (the Garden in the present paper) and several meters outside around the Garden, which is situated at 18-16 Fujimigaoka New Town, Oita City (about 80 meters above sea level; N33°10′, E131°23′). The size of the Garden including the building is 14 meters from east to west and 14.59 meters from south to north.

2. The house is situated on the western part of Fujimigaoka; its entrance opens to the road on the south side. The Garden is divided for convenience into 5 areas (A, B, C, D, and E as shown in Fig. 1 of Miyata, 2000). The area D is half-surrounded by *Abelia grandiflora* on the south and west sides, and many flowering plants grew there seasonally. During the three years of observation, most of the butterflies were observed in the area D. Therefore, in the present paper, "the Garden" generally refers to area D.

3. All observations throughout the three years were by the first author. Every butterfly observed at the Garden was recorded with the time and weather at the moment of its appearance. Even when a butterfly flew out for a moment only, he recorded it by identification based on his first impression. In the latter case, sometime the identification was rather difficult and could be wrong. Therefore, when a butterfly first appeared in the Garden, he tried to capture it for identification; if he failed to capture it, he did not record it unless he was convinced of the identification.

4. In contrast to the so-called "route census method", he did not adopt a fixed time for observation because he was working during the daytime at a university laboratory situated in a different place. Furthermore, the observation was not carried out regularly.

5. He preserved several butterfly specimens as a sample, but most of the butterflies captured were released after identification. He bred the larvae found in the Garden, and individuals that emerged were released after marking. In addition, he marked many butterflies caught in the Garden to find out whether they returned. However, he did not recover marked individuals except in the case of two species, perhaps because on weekdays his observation time was too short to see them even if they came back again. As a rare exception, he observed that *Mycalesis gotama* and *Ypthima argus* stayed in the garden for several days (Miyata, 2001).

Natural environment of the observation area (Fig. 1)

The development of Fujimigaoka New Town, Oita City, began in the 1970s. In the middle of 1980, most of remaining trees in the western 1/3 of the present town were cut down and the surface soil was taken off completely by bulldozers. The area was without green plants but with exposed brown soil for a long time. In 1986, the place of Miyata's house was still barren, and building of the house began that year. After that, many other houses were built gradually and trees were replanted by the owners of new houses.

As shown on the map, Fujimigaoka is situated on the northern slope of a low hill. The hilltop contains fields of rice and other crops belonging to the small settlements of Tabuki and Megusuno, both of which belong to Notsuharu Town, which is administratively not part of Oita City. The highest part of the hill is about 130 meters above sea level. From old times, there were fields of rice and other crops, plantations of *Morus bombycis* for breeding of silk worm, and *Quercus acutissima* for firewood and for cultivation of *Lentinus edodes*.

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Fig. 1. The map of Fujimigaoka New Town and neighboring area.

More recently, there were plantations of *Castanea crenata* and *Citrus unshiu*. However, secondary forests of miscellaneous small trees still remain on the higher part of the hill. There are *Cryptomeria japonica*, bamboo *Phyllostachys* spp., *Quercus glauca*, *Ficus erecta* etc. The southern part of the hilltop is an abrupt cliff that goes down about 50 meters to the Nanase River basin. The river winds its way from west to east through the basin. The wide overflowing area of the river has been used as cultivation area since several hundred

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years ago. Over the area other mountains, about 600 meters for the highest one, run from north to south. Therefore, Fujimigaoka is surrounded by a Golf Course in the west and fields of various crops in the other three directions. The other mountains are not connected directly to Fujimigaoka.

Native farmers live along the northern hillside near route 210 and near the southern hilltop. Administratively, the former belongs to Oita City and the latter to Notsuharu Town. The distance separating the two communities is less than two kilometers, but each community has its own Shinto shrine. This indicates that previously they had no cultural exchange such as marriage etc. Fujimigaoka New Town was developed as a terraced land on the northern slope between the two areas. However we do not know the original vegetation before development because all the plants and surface soil were removed. According to a vegetation map of Oita-prefecture published in 1976, Fujimigaoka was covered by Rhododendron —*Pinetum azuamanum*, Summergreen Oak forests and rice fields. Miyata's house is situated on the western part of the New Town near the Golf Course. The site might have been occupied previously by Summergreen Oak forests. At present several tall trees remain in a somewhat abrupt slope between the New Town and the farmer's settlement.

Miyata's house was completed in June 1987. He lived there for two years until 1989. Then, he worked in foreign countries such as Malaysia, Indonesia, China and Dominican Republic; in the last country he spent almost three years. He returned to the house in 1995, and until now he is living there. During the first two years from 1987, he did not hear the cicada's voice in summer and never saw reptiles or amphibians in the Garden. Since 1996, he saw a couple of kanahebi lizards (*Takydromus tachydromoides*) and Japanese toads (*Bufo japonicus*), and heard the voices of several species of cicada—*Graptopsaltria nigrofuscata*, *Cryptotympana facialis*, *Meimuna opalifera*, *Platypleura kampferi*, and finally *Tanna japonensis* in August 2000 in the Garden.

In 1998, the new campus of a Nurses' College was built on the southern hill belonging to Notsuharu Town, and most of the original trees there were cut down. In 1999, a Milk Company occupied the other large square. Again many trees were cut down, and all the rice fields on the hill disappeared completely. This destruction may affect the insect fauna of Fujimigaoka. Unfortunately, we have no record of butterflies on the hill before the destruction except our fragmental observation.

Results

Monitoring of butterflies was carried out at the Garden of Miyata's house of Fujimigaoka New Town for three years from 1998 to 2000.

In 1998, *Vanessa indica* was the first butterfly seen on March 15, and *Eurema hecabe* the last on December 19. A total of 36 species of butterfly was recorded at the Garden in that year. During 280 days from the first to the last observation day, he watched butterflies for a total of 103 days. Of the 103 days, 63 were holidays including Saturday, Sunday and National Holiday. The number of holidays in the 280 days was 90 days, therefore 63 days constituted 70% of the total holidays. Of the total of 190 weekdays butterfly watching was conducted on 40 days (21%). This means that more butterfly observations were conducted during holidays than weekdays. The average number of butterfly species was 5 on 63 holidays, 1 species on 20 weekdays, and 2–3 species on the remaining 20 weekdays. Although he often went shopping or do something during the holiday, the observation time during holiday, especially in the morning, was longer than that of the usual weekday.

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In 1999, the first butterfly to be observed was *V. indica* on March 27, and the last was the same species on December 29. Butterflies were observed on a total of 120 days out of 278 days between March 27 and December 29. A total of 38 species was observed in the year. As in the previous year, more butterflies were observed during holidays than weekdays.

In 2000, the first butterfly to be observed was again *V. indica* on February 11 and *E. hecabe*, *Argyreus hyperbius* and *Zizeeria maha* were the last on November 2. A total of 36 species was seen in the year. As described above, the first author built a new institute in Kokonoe Highland and he stayed there every holiday and stopped the monitoring at Fujimigaoka. If observation was continued until December, he might have recorded butterflies until the middle of December, because even in Kokonoe the average temperature was higher than that of usual years until the end of the month. Fig. 2 shows graphically the monthly changes of species number in butterflies and cumulative increase of species, with rainfall and the highest, the average and the lowest temperatures in Oita City.

During the three years of observation, the following 50 butterfly species were present in the Garden (the figure in parenthesis shows the total number of days the species was observed in three years).

A: Species observed every year (26 species)

Papilio xuthus (175 days), *Zizeeria maha* (167 days), *Papilio memnon* (155 days), *Argyreus hyperbius* (147 days), *Eurema hecabe* (123 days), *Ypthima argus* (91 days), *Pieris rapae* (85 days), *Pelopidas mathias* (67 days), *Parnara guttata* (58 days), *Papilio protenor* (58 days), *Narathura japonica* (54 days), *Pieris melete* (50 days), *Mycalesis gotama* (39 days), *Notocrypta curvifascia* (31 days), *Graphium sarpedon* (29 days), *Vanessa indica* (27 days), *Neptis sappho* (25 days), *Papilio helenus* (25 days), *Polygonia c-aureum* (16 days), *Curetis acuta* (12 days), *Cyrestis thyodamas* (10 days), *Papilio bianor* (5 days), *Papilio machaon* (5 days), *Ladoga camilla* (5 days), *Melanitis phedima* (5 days), *Celastrina argiolus* (4 days)

B: Species observed in two years (8 species)

Lycaena phlaeas (9 days), *Lethe diana* (7 days), *Kaniska canace* (4 days), *Neope gaschkevitschii* (4 days), *Everes argiades* (4 days), *Polytremis pellucida* (4 days), *Apatura metis* (2 days), *Parantica sita* (2 days)

C: Species observed in only one year (16 species)

Daimio tethys (2 days), *Isoteinon lamprospilus* (2 days), *Cynthia cardui* (2 days), *Lampides boeticus* (3 days), *Narathura bazalus* (2 days), *Papilio macilentus* (1 day), *Byasa alcinous* (1 day), *Graphium doson* (1 day), *Colias erate* (1 day), *Anthocharis scolymus* (1 day), *Nymphalis xanthomelas* (1 day), *Hestina japonica* (1 day), *Mycalesis francisca* (1 day), *Minois dryas* (1 day), *Libythea celtis* (1 day), *Ochlodes ochraceus* (1 day)

Butterflies that occurred every year for three years totaled 26 species. Among them, five species did not appear more than ten days in total. Their frequency of appearance is apparently not higher than that of two species listed in B. In contrast most of the 15 species listed in A were quite common in the Garden and it was easy to discover their larvae in the Garden and neighboring area, because their food plants were growing there. The presence of their food plants in the neighboring area was very important for their appearance. For example, *Kaniska canace* was not seen in 1998, but after planting the food plant (*Tricyrtis hirta*) in 1999, its larvae soon appeared on the plant, and the adult butterfly was observed near the breeding place. After that, we hope to see them every year in the Garden. In the case

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of *Papilio machaon*, the butterfly was uncommon, but its larvae were rather common on its food plants *Cryptotaenia canadensis* and *Foeniculum vulgare*.

Sixteen species listed in C were apparently very rare species in our place; ten of them were observed only one time each.

The maximum number of butterfly species observed for one day in 1998 was 11 species. More than 12 species were observed four times in total—three times in July and one time in August—for two years, 1999-2000. In these four times, five species—*Papilio xuthus*, *P. memnon*, *P. protenor*, *Eurema hecabe* and *Argyreus hyperbius*—were observed with certainty. These five species were regular visitors to the Garden in summer season:

July 24, 1999, Saturday—above five species, *Papilio helenus*, *P. macilentus*, *Neptis sappho*, *Ypthima argus*, *Zizeeria maha*, *Daimio tethys*, *Pelopidas mathias*, and *Parnara guttata* (13 species);

August 7, 1999, Saturday—five species, *Papilio helenus*, *P. machaon*, *Pieris melete*, *Ypthima argus*, *Zizeeria maha*, *Pelopidas mathias*, and *Parnara guttata* (12 species);

July 16, 2000, Sunday—five species, *Papilio helenus*, *P. bianor*, *Pieris rapae*, *Ypthima argus*, *Naranthura japonica*, *Isoteinon lamprospilus*, and *Notocrypta curvifascia* (12 species); and

July 23, 2000, Sunday—five species, *Graphium sarpedon*, *Pieris melete*, *Zizeeria maha*, *Naranthura japonica*, *Notocrypta curvifascia*, *Pelopidas mathias*, and *Parnara guttata* (12 species).

Time of appearance of butterfly in a day

According to Ae (1997), the route census method in Monks Wood National Conservation Area of Nature, England, requires that the observer must be walking through a regular route for the fixed five hour from 10.45 a.m. until 3.45 p.m. and must record all butterflies appearing. Such fixation of observation time may not be suitable for different geographical situations. We have only fragmental data for this, because our observation time was limited as mentioned above. However, in the summer season at Oita City, most butterfly species seemed to appear in the garden from 7.00 a.m. to 12.00 noon, especially from 8.00 a.m. to 10.00 a.m. After 11.00 a.m. the number of butterfly species and individuals apparently decreased, and until evening they took afternoon rest. At about 4.00 to 4.30 p.m. the number of species and individuals increased again gradually and after 6.00 p.m. most of them disappeared. In conclusion, during summer season 70 to 100% of the butterflies of the day were observed in the morning. When it rained, almost all the butterflies disappeared and reappeared when weather condition recovered. An exceptionally large number of butterflies appeared on a fine day following several rainy days. In spring and autumn, the time of appearance of butterflies was later, coupled with early disappearance compared to the summer season. As above mentioned, it seems that temperature and humidity might affect butterfly activity (Fig. 2), but we do not have enough data to discuss this problem.

Seasonally July had the greatest butterfly activity in Fujimigaoka, with a total of 20 species recorded in 1998, 24 species in 1999 and 25 species in 2000. August was also a good month. Of the other months, May was good with 13-19 species recorded in three years. For example, 19 species were observed in May 1999; among them were very rare species: *Graphium doson*, *Colias erate* and *Anthocharis scolymus* were recorded for the first time in the Garden but were never seen again. June was not a good season, with the butterfly

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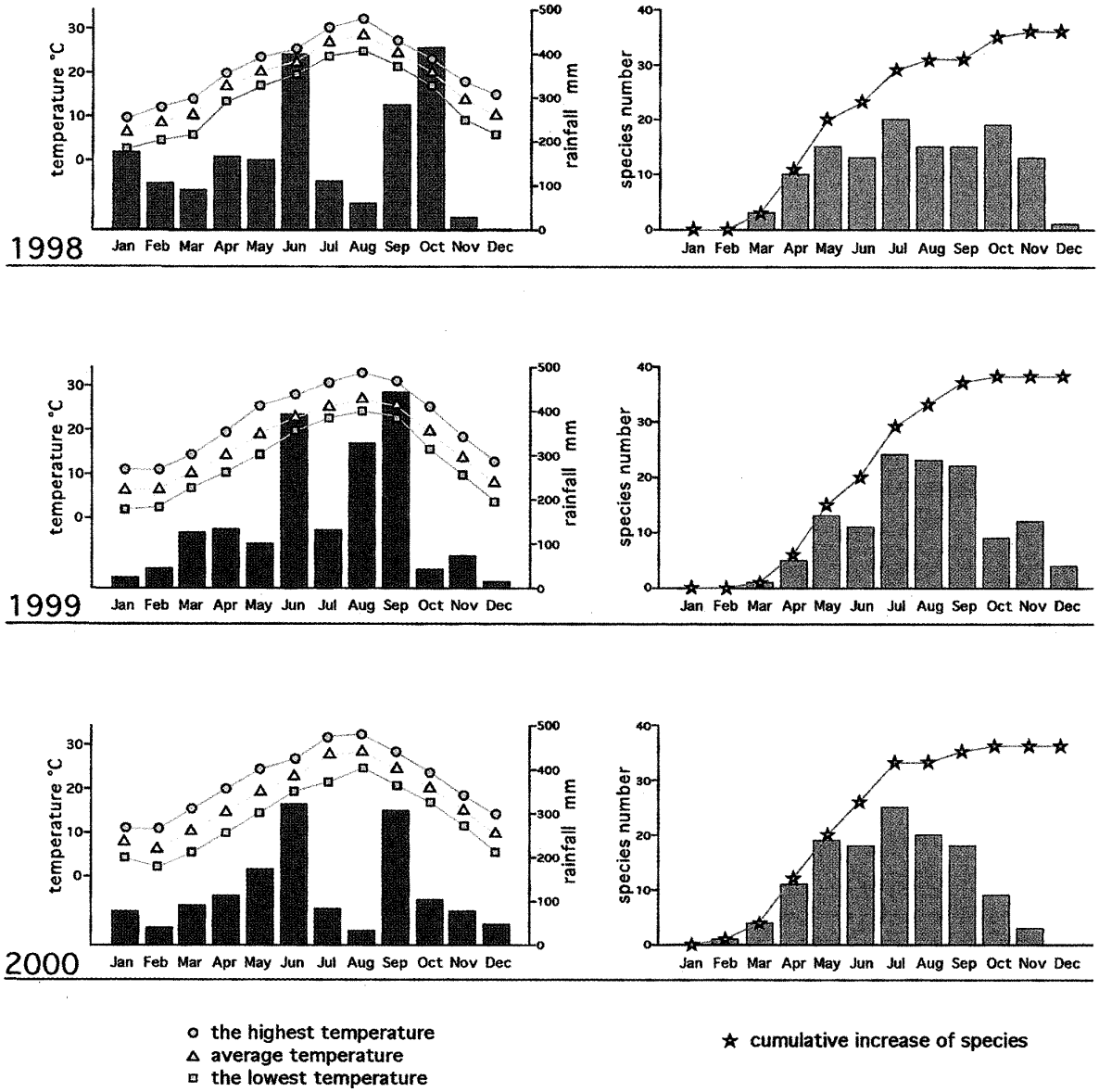

Fig. 2. Monthly changes of species number in butterflies and cumulative increase of species (right) and temperatures and rainfall (left).

activity apparently dropping sharply. This sharp drop was observed every year, and individual numbers declined for a time even in regular members such as *Papilio xuthus* and *P. memnon* (Table 1). From the breeding of these butterfly larvae, the period of decline corresponded to the larval period originating from eggs of the first generation females. During May and June, their growth was slower than that in summer, and their adult number decreased temporarily. Especially in the most common species, *P. xuthus*, where the adult was not observed in the latter half of May throughout all three years. In *P. memnon* and *P. protenor*, adults were very few in the first half of June. Although the rainy season might cause the decline of butterfly numbers in June, the lower temperature in this period appears to be more important as the growth of larva was slower than mid summer. At the beginning of July, despite rainy days still continuing the temperature was already going up, and *P. memnon* and *P. protenor* were observed often flying actively even on rainy days.

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In September, October and November, we believe that the weather conditions and temperature were very favorable to butterfly activity. For example, in October of 1998, 19 species were recorded in a month; among them four species were recorded for the first time in the year. Generally after September butterfly numbers decreased gradually in proportion to the drop in temperature (Fig. 2). If the observation day was very fine, even in autumn, many species were seen.

A total of 50 species of butterfly was recorded in the Garden for three years (1998–2000). It comprised about 40% of the butterfly species recorded in Oita Prefecture by Miyake and Tamashima (1999). The abundance and decline in number in each butterfly species are given in Table 1. Two methods were used for evaluation of individual numbers as follows:

First, calculation of total number of days in which the species was observed in each year, and the grand total number of days in three years. Because, in most species, individual number usually corresponded with the total number of days. Common or abundant species might appear often or every day, therefore total number of days is useful for evaluation of individual number.

However, if individual numbers were very large but appearance was not frequent, the total number of days of such species was not so large. Therefore, we used a second method of evaluation, in which the individual number of each half month was used to evaluate by following three levels:

○: Very rare species. Seen only one day or only one individual recorded in a half month.
◎: Common species. Seen for 2–4 days or 2–4 individuals seen in a half month.
●: Abundant species. Seen more than 5 days or 5 individuals seen in a half month.

The first half-month means days 1–15, the latter half-month days 16–30 (or 31) in each month. Therefore, the predominant species in the Garden had high total number of appearance days and many black circles. In rare exception, it is clear by marking that the same individuals of *Mycalesis gotama* and *Ypthima argus* appeared continually for several days. However, we counted in the table all the days that the butterfly appeared as the total number of days, even if it was the same individual. We attempted to mark some other species such as *Papilio xuthus*, *P. memnon*, *Argyreus hyperbius*, *Eurema hecabe*, *Pieris rapae* and *P. melete*, but these marked individuals were never re-observed at the Garden.

The following fifty species were recorded in three years.

Family Papilionidae (10 species)

1) *Papilio memnon thunbergii* ナガサキアゲハ
Next to *Papilio xuthus* and *Zizeeria maha*, this was the third commonest species. It was observed in 155 days over the three years, and was one of the regular members at the Garden from April to October. Its larva often appeared on *Citrus* sp. Especially from April to June, many larvae belonging to the first generation ate all the leaves of the tree; larvae of second generation were fewer because of the shortage of leaves.

2) *Papilio protenor demetrius* クロアゲハ
Next in abundance to *P. xuthus* and *P. memnon* in the family Papilionidae, this species appeared 58 days in three years. Its larvae fed on *Citrus* sp. from April to June together with *P. memnon*.

3) *Papilio xuthus* アゲハチョウ
This was the most common butterfly among the 50 species. It was observed in 175 days

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over three years. Several individuals often sucked nectar on the hedge of *Abelia grandiflora*. Its larvae were sometimes found on *Citrus* sp.

4) *Papilio helenus nicconicolens* モンキアゲハ
This species was seen two days in 1998, 16 days in 1999 and 7 days in 2000, with a total of 25 days in three years. In most cases, the butterfly appeared in the evening from the west direction and flew off to the east.

5) *Papilio bianor dehaanii* カラスアゲハ
This butterfly was not so abundant, and was seen 1-2 times in each year.

6) *Papilio machaon hippocrates* キアゲハ
This species was not so abundant as *P. bianor*, but its larvae were often found on *Feoniculum vulgare* and *Cryptotaenia canadensis* at the Garden.

7) *Papilio macilentus* オナガアゲハ
A female of this species was caught while flying intertwined with *P. protenor* on the hedge of *A. grandiflora* at 4.05 p.m. on July 24, 1999.

8) *Byasa alcinous alcinous* ジャコウアゲハ
This species was sometimes seen near Fujimigaoka; a female was observed in the Garden at 12.55 p.m. on June 27, 1999 but it flew out to the north direction.

9) *Graphium sarpedon nipponum* アオスジアゲハ
This species was rather common in Fujimigaoka. Its larvae were easily found on *Cinnamomum camphora* which were planted as roadside trees in some parts of Fujimigaoka New Town. Usually the butterfly was very scarce at the Garden. It appeared only four days each in 1998 and 1999, but in 2000, individual numbers were very large and it was observed on 21 days in the year; most of them flew in from the west and just touched the hedge of *A. grandiflora* before flying off to the east.

10) *Graphium doson albidum* ミカドアゲハ
This species was not seen in the Garden until May 5, 2000 when an individual flew in from the east at 11.35 a.m., explored the Garden, then flew off to the west.

Family Pieridae (5 species)

1) *Pieris rapae crucivora* モンシロチョウ
Next to *Eurema hecabe* in abundance, this species was recorded on 85 days over three years. Its numbers gradually increased from April to July, dropped drastically during mid-summer, and in autumn some individuals reappeared. Larvae were also easily found on *Brassica* spp. planted in the Garden in May and June.

2) *Pieris melete* スジグロシロチョウ
This species was observed on 50 days over three years. It disappeared at the end of the rainy season, because it preferred to stay in somewhat dark and high humidity places compared with *P. rapae*. The larvae fed on *Brassica* spp. and also grew on a nasturtium, *Tropaeolum majus* until imago; the female of *P. rapae* did not like this plant and never approached it.

3) *Eurema hecabe* キチョウ
This was the fifth most abundant species among the 50 species. It was observed on 123 days over three years. It was abundant especially in mid-summer even after *Pieris* spp. had disappeared.

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Table 1. Monthly butterfly records at Fujimigaoka New Town, Oita City (1998-2000).

Species	Year	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Days*
1. *Papilio xuthus* アゲハチョウ	1998			◎	◎	●●	●●	●●	●●				43
	1999			○	●	○●	●●	●●	●●				60
	2000			○●	●	●	●●	●●	●●	◎			72
2. *Papilio machaon* キアゲハ	1998				○								1
	1999						○	○					2
	2000					○		○					2
3. *Papilio memnon* ナガサキアゲハ	1998			○●	●◎	●	●○	●●	●●	◎●	○		50
	1999				●◎		●●	●●	●●				50
	2000			○	●●	○	●●	●●	●◎	◎			55
4. *Papilio protenor* クロアゲハ	1998			○	○○	◎	◎◎	◎○	○				15
	1999					◎	◎●	●●	●○				20
	2000			○	◎	○	●●	◎◎	○○				23
5. *Papilio macilentus* オナガアゲハ	1999						○						1
6. *Papilio bianor* カラスアゲハ	1998						○						1
	1999						○	○					2
	2000						◎						2
7. *Papilio helenus* モンキアゲハ	1998						○			○			2
	1999					○	●	◎○	◎○				16
	2000						◎◎	○	○				7
8. *Byasa alcinous* ジャコウアゲハ	1999					○							1
9. *Graphium sarpedon* アオスジアゲハ	1998			◎			○○		○				4
	1999				◎				○				4
	2000				◎		●◎	●◎	◎○				21
10. *Graphium doson* ミカドアゲハ	2000				○								1
11. *Pieris rapae* モンシロチョウ	1998		○	◎◎	○●	◎	◎○	○○		◎◎	○		21
	1999			◎◎	◎	◎	●●	◎	○◎				30
	2000		◎	◎●	●●	●●	◎●	◎		◎			34
12. *Pieris melete* スジグロシロチョウ	1998				◎	●◎	◎			◎			14
	1999			○	◎	○	●○	○					14
	2000			○◎	◎	●●	◎○						22
13. *Eurema hecabe* キチョウ	1998		○	◎	○		◎●	◎●	●●	●●	◎	○	37
	1999				◎		◎◎	●●	●●	◎◎			33
	2000		◎	○		○	○●	●●	●●	●◎	○		53
14. *Colias erate* モンキチョウ	2000				○								1
15. *Anthocaris scolymus* ツマキチョウ	2000				○								1
16. *Argyreus hyperbius* ツマグロヒョウモン	1998				◎◎	●●	●●	●●	◎	◎◎	◎		38
	1999				◎	●	●●	●●	◎●	◎●	●	○	45
	2000			●	●○	●	●●	●●	◎◎	◎◎	○		64
17. *Nymphalis xanthomelas* ヒオドシチョウ	1998			○									1
18. *Vanessa indica* アカタテハ	1998		○						○		◎		3
	1999		○			○		○		◎	◎◎	○○	10
	2000	○	○	○	○○	◎	●○					○	14
19. *Cynthia cardui* ヒメアカタテハ	2000						○	○					2
20. *Polygonia c-aureum* キタテハ	1998									◎	◎		4
	1999									●	◎◎		7
	2000		◎		○			○	○				5
21. *Kaniska canace* ルリタテハ	1999							○				○	2
	2000								○	○			2
22. *Ladoga camilla* イチモンジチョウ	1998				○					○			2
	1999								○				1
	2000					○		○					2
23. *Neptis sappho* コミスジ	1998			◎			○	○	○	○			5
	1999				○		○		◎				4
	2000			○	◎○	○	◎	◎◎	○○				16
24. *Hestina japonica* ゴマダラチョウ	1999								○				1
25. *Apatura metis* コムラサキ	1998						○						1
	2000						○						1

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26. *Cyrestis thyodamas* イシガケチョウ	1998				○					○	○		3
	1999						○		○		○	◎	4
	2000					○	○		○				3
27. *Minois dryas* ジャノメチョウ	1999						○						1
28. *Mycalesis francisca* コジャノメ	1999				○								1
29. *Mycalesis gotama* ヒメジャノメ	1998				◎	◎○			○○				7
	1999				○			○	◎◎				6
	2000					◎○	●	●◎	◎◎				26
30. *Ypthima argus* ヒメウラナミジャノメ	1998				◎○	◎	●	◎◎	◎○				18
	1999				◎		●●	◎●	●◎				26
	2000				●◎	○	●●	◎●	●◎	○			47
31. *Neope gaschkevitschii* サトキマダラヒカゲ	1998				◎		○						3
	1999							○					1
32. *Lethe diana* クロヒカゲ	1999				○		◎		◎○				6
	2000				○								1
33. *Melantis phedima* クロコノマチョウ	1998									◎○			3
	1999							○					1
	2000								○				1
34. *Parantica sita* アサギマダラ	1998					○							1
	1999								○				1
35. *Libythea celtis* テングチョウ	1998									○			1
36. *Narathura japonica* ムラサキシジミ	1998			◎		◎●	◎	◎	○◎	○			17
	1999					○	◎◎	○○	◎◎	◎			13
	2000					◎	○●	●○	◎◎				24
37. *Narathura bazalus* ムラサキツバメ	1998									○	○		2
38. *Zizeeria meha* ヤマトシジミ	1998				○	○	◎●	◎●	◎●	●●	●		36
	1999			◎	◎	○●	●●	●●	●●	◎●	◎◎		58
	2000			○◎	●◎	○●	●●	●●	●●	●●	○		73
39. *Celastrina argiolus* ルリシジミ	1998			◎	○								2
	1999						○						1
	2000						○						1
40. *Everes argiades* ツバメシジミ	1998						○			○			2
	2000				○	○							2
41. *Lampides boeticus* ウラナミシジミ	1998									○	◎		3
42. *Lycaena phlaeas* ベニシジミ	1999			◎		○							3
	2000			◎◎	○	○							6
43. *Curetis acuta* ウラギンシジミ	1998						○		○●	◎			9
	1999							○	○				2
	2000							○					1
44. *Polytremis pellucida* オオチャバネセセリ	1998					◎							3
	1999							○					1
45. *Pelopidas mathias* チャバネセセリ	1998						○●	●●	○○	●◎			21
	1999						○◎	●●	○	●	○		21
	2000					○	●	●●	○				25
46. *Parnara guttata* イチモンジセセリ	1998							○●	○	○◎	○		8
	1999					○	●●	●●	○		○		23
	2000						●●	●●	◎◎				27
47. *Isoteinon lamprospllus* ホソバセセリ	2000						◎						2
48. *Daimio tethys* ダイミョウセセリ	1999						○	○					2
49. *Ochlodes ochraceus* ヒメキマダラセセリ	1998							○					1
50. *Notocrypta curvifascia* クロセセリ	1998					◎	◎◎	○	◎				8
	1999						◎◎	◎	●○	○			16
	2000				○		◎◎	◎					7

Days*→Total of appearance days in each year.

○→Very rare species. Only one day or only one individual recorded in a half month.

◎→Common species. 2-4 days or 2-4 individuals seen in a half months.

●→Abundant species. More than 5 days or 5 individuals seen in a half month.

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4) *Colias erate poliographus* モンキチョウ
This species was recorded only once at 2.05 p.m. on May 7, 2000. It flew from east to west about two meters above the road. This butterfly was rather common in Fujimigaoka, especially in overgrown vacant land.

5) *Anthocharis scolymus* ツマキチョウ
This species emerged in spring only. We caught a female specimen in another part of Fujimigaoka. It was not found at the Garden until May 6, 2000 when a female was observed at 1.40 p.m. laying eggs on *Rorippa nasturtium-aquaticum* in the Garden.

Family Nymphalidae (11 species)

1) *Argyreus hyperbius* ツマグロヒョウモン
This was the commonest species of Nymphalidae. It was recorded on 147 days over three years. They hibernated in the larval stage among a growth of pansy, *Viola*×*Witcrockiana*, one of the important food plants in this district. During winter, they fed on the plant on warmer days and pupated at the end of March, then emerged in the middle or end of April. In newly developing residential area in Oita Prefecture, the young pansy is always planted in the garden in late autumn; it grows and flowers even in winter.

2) *Polygonia c-aureum c-aureum* キタテハ
This species was observed on 16 days over three years. Usually it was observed in spring and in autumn, but disappeared during summer.

3) *Vanessa indica* アカタテハ
This species was seen on 27 days in three years. Compared with *P. c-aureum*, *V. indica* occasionally sucked nectar on *Abelia grandiflora* in summer.

4) *Cynthia cardui* ヒメアカタテハ
Although this was a common species in the grasslands of Fujimigaoka New Town, it was seen only twice at the Garden sucking nectar on *A. grandiflora*: (i) July 31, 2000: a male seen at 8.30 a.m., and (ii) August 31, 2000: an individual, probably female, seen at 7.15 a.m.

5) *Nymphalis xanthomelas japonica* ヒオドシチョウ
This was a very rare species in Fujimigaoka. A female specimen was captured while sucking the flower of *Prunus*×*Edoensis* on April 5, 1998.

6) *Kaniska canace nojaponicum* ルリタテハ
This species was rarely seen in Fujimigaoka. We observed it at the Garden only on four days over three years. However, since planting a food plant, *Tricyrtis hirta*, in 1999, larvae of *K. canace* appeared on the plant in September 2000. Having consumed all the leaves of *T. hirta*, the larvae switched to feed on a lily, *Lilium speciosum*. The adult emerged at the end of September. *L. speciosum* had been grown for several years in the Garden, but larva of *K. canace* was never seen on the plant before.

7) *Apatura metis substituta* コムラサキ
A female was seen flying around *Populus alba* and trying to lay an egg on a leaf on July 26, 1998. She stopped on the surface of the leaf and bent the end of her abdomen to its under side to lay the egg. After her departure no egg was found on the leaf, despite careful search. On a second occasion, a male was caught resting on a leaf of *Ailanthus altissima* at 8.25 a.m. on July 25, 2000.

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8) *Hestina japonica* ゴマダラチョウ
A fresh dead body was taken on the road outside area D on June 2, 1996. An individual was observed flying off slowly from west to east at 11.15 a.m. on September 25, 1999. In some house gardens in Fujimigaoka New Town, there are several large trees of *Celtis sinensis* var. *japonica*, which is a food plant for *H. japonica*.

9) *Neptis sappho intermedia* コミスジ
One of the regular species in the Garden, it was observed on 5 days in 1998, 4 days in 1999, and 16 days in 2000.

10) *Ladoga camilla japonica* イチモンジチョウ
This species was seen every year but the number of appearance days was only five for three years.

11) *Cyrestis thyodamas mabella* イシガケチョウ
Three years ago this species was very rare and not seen in Fujimigaoka New Town. At that time many larvae were often observed on *Ficus erecta* at Megusuno, Notsuharu Town, about half a kilometer from the Garden. In 1998 we encountered for the first time this butterfly at the Garden and also in other places of Fujimigaoka. It was subsequently seen every year with a total appearance of 10 days in three years.

Family Satyridae (7 species)

1) *Neope gaschkevitschii* サトキマダラヒカゲ
This species was seen in 1998 and 1999, totaling 4 days; it was not seen in 2000.

2) *Minois dryas bipunctata* ジャノメチョウ
This species was rather common and was seen several times in neighboring Fujimigaoka. One of its breeding places seemed to be a Golf Course adjacent to the western side of Fujimigaoka. The distance to the Course from the Garden is 50 meters. However, it was observed only once at the Garden at 9.45 a.m. on July 20, 1999.

3) *Mycalesis gotama fulginia* ヒメジャノメ
This species was observed on 7 days in 1998, 6 days in 1999, and 26 days in 2000. In the last year, some individuals were marked to observe their behavior at the Garden; they maintained a small territory for several days (Miyata, 2001).

4) *Mycalesis francisca perdiccas* コジャノメ
A male resting on *Abelia grandiflora* was taken for the first time at 12.25 p.m. on May 9, 1999.

5) *Ypthima argus* ヒメウラナミジャノメ
This, the commonest species of Satyridae, was observed on 71 days in three years. As for *M. gotama*, this species maintained a small territory for several days (Miyata, 2001).

6) *Lethe diana* クロヒカゲ
This species was seen on 6 days in 1999, with more than two individuals seen at 4.20 p. m. on September 12. It was not recorded in 1998, and only once in 2000 (May 29).

7) *Melanitis phedima oitensis* クロコノマチョウ
This species was observed every year, but with a total appearance of 5 days only.

Family Danaidae (1 species)

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1) *Parantica sita niphonica* アサギマダラ
Only two individuals were observed, one on June 29, 1998, and the other on September 23, 1999.

Family Libytheidae (1 species)

1) *Libythea celtis celtoides* テングチョウ
This species was only observed on October 24, 1998 on the hedge of *Abelia grandiflora*. It was very rare at the Garden, but we have one old record of this butterfly resting on a pansy flower on March 8, 1997.

Family Lycaenidae (7 species)

1) *Narathura japonica* ムラサキシジミ
This was a very common species and was observed on 54 days in three years. In Oita Prefecture, the adult probably hibernated as very old individuals appeared in early spring. It might also be possible that hibernation occurred in pupal or larval stage, because in late autumn (November 27, 1999) several larvae of this butterfly were found on a secondary shoot of *Quercus glauca* produced after cutting its branches in October. Except one, the other larvae escaped through a gap between the net and the shoot. This larva pupated, then hibernated alive during winter in a room, but in spring it died. The cause of its death was unknown, but might be that the room was very dry during winter.

2) *Narathura bazalus turbata* ムラサキツバメ
This species was seen twice only, on October 24 and November 15, 1998.

3) *Zizeeria maha argia* ヤマトシジミ
This was a very common species next to *Papilio xuthus*, with a total appearance of 167 days. Larvae were also often found on *Oxalis corniculata*. Hibernation occurred in the larval stage (Miyata, 1999).

4) *Celastrina argiolus ladonides* ルリシジミ
This was a rather rare species. Its identification on the spot is sometimes difficult. A female was captured resting on a plant near *Prunus mume* in area A on July 26, 2000.

5) *Everes argiades hellotia* ツバメシジミ
This species was seen on 2 days each in 1998 and 2000, but none in 1999. Its identification on the spot is somewhat difficult vis-a-vis *Z. maha* and *C. argiolus*.

6) *Lampides boeticus* ウラナミシジミ
This species was not rare outside Fujimigaoka, but was seen at the Garden only twice in 1998. Unfortunately, it was not caught on either occasion. However, on first impression, they were apparently different from *Z. maha*, *C. argiolus* and *E. argiades*, hence they were regarded as *L. boeticus*.

7) *Lycaena phlaeas daimio* ベニシジミ
This species was common in Fujimigaoka, but at the Garden it was not observed in 1998. It was seen on 3 days in 1999 and 6 days in 2000.

Family Curetidae (1 species)

1) *Curetis acuta paracuta* ウラギンシジミ
This species was seen every year. In the late autumn of 1998, its number was especially abundant and on a fine day several males glittering under sunshine flew above a hedge of *Quercus glauca*.

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Family Hesperiidae (7 species)

1) *Polytremis pellucida* オオチャバネセセリ
This species was not common in the city area, and sometimes very difficult to identify because of the presence of other similar species.

2) *Pelopidas mathias oberthueri* チャバネセセリ
This species was abundant in July and August on the hedge of *Abelia grandiflora*, with a total appearance of 67 days in three years.

3) *Parnara guttata guttata* イチモンジセセリ
This species was also abundant in July and August together with *P. mathias* on *A. grandiflora*. It was seen on 58 days in three years.

4) *Isoteinon lamprospilus lamprospilus* ホソバセセリ
This species was seen for the first time at 2.15 p.m. on July 16, 2000, on the flower of *Chrysanthemum* sp. in area A. It appeared again and finally a male resting on a leaf near *A. grandiflora* in area D was caught at 6.40 a.m. on July 18.

5) *Daimio tethys* ダイミョウセセリ
This species was seen only twice in 1999, sucking nectar on the hedge of *A. grandiflora*.

6) *Ochlodes ochraceus* ヒメキマダラセセリ
A male of this species resting on a grass stem was taken in the early morning of August 11, 1998 in area D. Before that it was not observed in Fujimigaoka and its surrounding area.

7) *Notocrypta curvifascia curvifascia* クロセセリ
This was a regular species and was seen on 31 days in three years. Its larvae were also very common on *Zingiber mioga* from May to September.

The following three species were not seen at the Garden, but they were collected near Fujimigaoka within 500 meters of the Garden:

Sasakia charonda charonda オオムラサキ
Argynnis paphia tsushimana ミドリヒョウモン
Antigius attilia ミズイロオナガシジミ

Conclusion

The first author conducted butterfly watching at his house garden, 18-16 Fujimigaoka New Town, Oita City, for three years, from 1998 to 2000. The observation was carried out only for several hours when he was at home. Usually a white-collar worker can observe butterflies for only two or three hours in the morning and in the evening on weekdays. Even during holiday, he cannot observe butterflies full time, because he has family, and he has to do shopping with his wife and visit someone for private purpose, and so on. However, we examined the first author's results and concluded that within such limitations, if one could continue observation everyday in his garden for a year, one could obtain enough knowledge of the butterflies in the municipality where one's house is situated. Because most of the common species in the place would often appear, he has opportunity to see them in the morning or evening. In the case of rare species observed only one time in three years, for example, *Isoteinon lamprospilus* and *Ochlodes ochraceus*, they were observed in the morning. Therefore, it is clear that even if observation time is limited, continuation to watch butterfly

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every year will yield good results.

The purpose of the activity in "Monitoring butterfly in each house garden" proposed by the Committee of the Nature Conservation of the Lepidopterological Society of Japan is to accumulate above-mentioned fragmental observations of butterflies by amateur lepidopterologists. And by the accumulation, we can understand any change, and possibly the cause(s) of the change, in butterfly fauna throughout the country. Our method is quite different from "route census method", *i. e.* without route and without fixing specific time for observing butterflies.

Our method is very simple and very easy to practise because it requires only a notebook, a ball pen or pencil, and continuation of watching butterflies in a garden when at home. We hope that more lepidopterologists will join us and conduct butterfly watching in their gardens. It is necessary to accumulate such records to elucidate the relationship between change(s) of local butterfly fauna and global warming. If the method were improved, more butterfly species might be recorded. After examination in detail of Miyata's records of the three years, and in-depth discussion and analysis we conclude as follows:

1. A minimum knowledge is required to identify butterflies in the area. We recommend a camera and a butterfly net for obtaining confirmatory evidence.

2. More butterfly species were observed during holidays than weekdays. According to the records for 1998, of the 280 days from the day when the first butterfly was seen (March 15) to the day of the last butterfly seen (December 19), there were 90 holidays and 190 weekdays. Butterflies were observed in 63 holidays and 40 weekdays. In brief, butterflies were seen in 70% of holidays but only 21% of weekdays. The average number of butterflies seen in 63 holidays was 5 species, but only one species was seen in half of the 40 weekdays, and 2 to 3 species in the other 20 weekdays. In conclusion, holiday is very important for recording many butterfly species, because the observation time during holiday is longer than on weekdays.

3. The importance of holiday is an obvious fact as discussed above. What part of the day is important for observation? We examined four holidays (3 days in July and 1 day in August) in which more than 12 species of butterflies were observed in a day over the three years. In these days, most of the butterfly species appeared from 7 in the morning to noontime in Oita City, with a clear peak of butterfly activity from 8 to 10 o'clock in the morning. After 11 o'clock in the morning, the number of butterflies apparently decreased, and during the hottest period of the day they disappeared, then around half past 4 in the afternoon, some of butterflies appeared again. In other words, 70% to 100% of the butterfly species that appeared in the day were already observed in the morning. Less than 30% of the species that appeared in the day were added in the afternoon. Therefore, on a fine day if the observer stayed in his garden until 10 o'clock in the morning, he should record most of the butterflies that would appear in the day. And if he were home at around four-thirty in the afternoon, it might be possible to observe *Papilio helenus* and 2 to 3 more species which were usually not seen before noontime.

4. In spring and autumn, the time of appearance of butterflies may become later and most of the butterflies may disappear earlier. Therefore, daytime observation may be necessary in these seasons. However, in Kyushu a few butterfly species only appeared one time in spring or in autumn, and opportunities to observe them may be limited.

5. It is necessary to record every information such as individual number seen at the same

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time, time of appearance, etc., because such data are sometime very useful regarding frequency of appearance and behavior of each species. However, usually three to four levels are enough for evaluation of individual numbers as shown in Table 1. In some species, individual numbers fluctuated sharply during the 3 years. For example, *Papilio helenus* in 1999 and *Graphium sarpedon* and *Argyreus hyperbius* in 2000 were extremely numerous compared with the other two years. Their numbers could not be expressed completely by the levels used in Table 1.

6. If larvae of butterflies are discovered on food plants, they must be reared until their emergence. Such records are useful for discussing environment impact.

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摘　　要

環境指標としてのチョウ類 大分市の個人住宅の庭におけるモニターリングの試み (宮田　彬・池田八果穂・長谷川英男・藤崎晶子・揚　海星)

日本鱗翅学会自然保護委員会の提唱を受け入れ，1998 年から 2000 年の 3 年間，大分市富士見ヶ丘 18-16 の宮田宅の庭で継続したチョウ観察の記録を再検討した．3 年間に合計 50 種のチョウが記録されたので，それらのチョウの記録時の状況と個体数の多さの程度を，(1) 年間の延べ出現日数と (2) 半月毎の個体数の多さを表す 3 段階評価法の二通りの方法で示した (第 1 表)．その結果，今回著者らが採用した方法は，ルート・センサス法と同様チョウのモニターリングの有効な一方法として推奨出来るという結論に達した．この方法では一定の観察場所として個人の庭とその庭から観察可能な数メートルほどの外側を含む地域を決めた．しかし一定の観察時間は設けず，たまたま在宅し，庭へ出たりあるいは庭を見たときに見かけたチョウの記録を随時取ることにした．もちろんチョウを見た時間，その時の天候，個体数，チョウは何をしていたか等を参考のため記録しておく．通常，サラリーマンの場合，観察時間は朝夕の短い時間と週末の休日，祭日だけに限定される．その休日も様々の事情で必ずしも在宅出来るとは限らない．忙しい時は帰宅時間も遅いし，休日も一日中家を空けることが多い．しかしそのような状態でも年間を通して記録を継続した．3 年間の記録を調べて見ると，確かに休日にチョウを見かける機会が圧倒的に多く，もし休日がまったくないとすれば記録される種類数は著しく減少することが予想される．とは言えどんなに忙しい身でも休日の朝は少し遅く外出する場合が多く，午後も少し早く帰宅することが多い．そこで休日の場合，どの時間帯にもっともチョウが多いか検討してみた．夏の観察では，7-12 時の午前中にその日記録されたチョウの 70-100% が飛来した．しかも 8 時から 10 時までの 2 時間に多くの種類が現れるピークがあった．そして午後の暑い時間帯はチョウの個体数が著しく減少する中休みがあり，夕方，4 時から 4 時半に再び多くのチョウが飛来する時間があることが分かった．このようなことを少し考慮して，休日の外出を朝 10 時少し前まで遅らせる事が出来るならば，夏のチョウはだいたい漏らさず記録可能であることが分かった．また午後 5 時までに帰宅して観察を再開すればさらにいくつかの種が追加されるかも知れない．以上

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のようなことを少し意識して休日の観察可能な時間を設定するならば，昼間別の場所で働いている多忙な人でも庭のチョウの観察運動に参加し重要な役割を果たすことができる．むしろ断片的な記録を全国的に集積することによって見えてくることがあるに違いないと確信した．チョウのモニターリングに多くの人が参加することを期待したい．

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